OPEN ACCESS
Quick Response Code:
Website: https://wgges.us

Creative Commons (CC BY-NC-SA 4.0):
This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International Public License, which allows others to remix, tweak, and build upon the work noncommercially, as long as appropriate credit is given and the new creations ae licensed under the identical terms.

Manuscript ID:
IJWGAFES-2026-030405

DOI: 10.5281/zenodo.23409275
DOI Link:
https://doi.org/10.5281/zenodo.23409275

Volume: 3
Issue: 4
April
Year: 2026
E-ISSN: 3066-1552

Submitted: *06 Mar. 2026*
Revised: *12 Mar.2026*
Accepted: *05 Apr.2026*
Published: *30 Apr. 2026*

[1]Research Scholar, Walchand College of Arts & Science, Solapur
Email: mohankale35@gmail.com

[2]Research Guide, Walchand College of Arts & Science, Solapur

Address for correspondence:
Kale Mohan Kalidas
Research Scholar, Walchand College of Arts & Science, Solapur
Email: mohankale35@gmail.com

How to cite this article:
Kale, M. K., & Todkari, G. U. (2026). Road Transport Development and Regional Development in Solapur District: A Correlation Analysis, 2001–2021. International Journal of World Geology, Geography, Agriculture, Forestry and Environment Sciences, 3(4), 34–37.
https://doi.org/10.5281/zenodo.23409275

Road Transport Development and Regional Development in Solapur District: A Correlation Analysis, 2001-2021

Kale Mohan Kalidas[1], Dr. Todkari Govindrao Uttam[2]

Abstract

Does building roads make a region develop, and if so, which parts of it? This paper tests that relationship for Solapur district by correlating a composite index of road transport development with fourteen socio-economic indicators, once for 2001 and again for 2021, and then measuring how each correlation changed over the two decades. The change is the most revealing part. In 2001, road development had little statistical connection to industry, healthcare or school provision, and in several cases the association was actually negative. By 2021 those same relationships had turned strongly positive: the correlation with factory density rose from near zero to 0.81, with hospitals from −0.13 to 0.69, and with schools from −0.66 to 0.81. Population density and road density both strengthened. Agricultural indicators moved the other way or barely moved at all, and the link with rural population became more strongly negative. The pattern is consistent and pointed. Over twenty years road transport shifted from a passive background facility to an active driver of development, but the development it drove was industrial, institutional and urban, not agrarian. The result supports the study's two hypotheses while exposing a widening rural–urban divide.

Keywords: *road transport, regional development, Pearson correlation, temporal change, rural–urban divide, Solapur district*

Introduction

It is easy to assume that roads and development go together, and harder to say exactly how. Roads might lead development, following it, or simply sit alongside it without much causal traffic in either direction. The honest way to approach the question is to measure the association and watch how it behaves over time, rather than assert a link and look for confirming examples. That is what this paper does for Solapur district, a semi-arid district in south-eastern Maharashtra that expanded and reclassified its road network substantially between 2001 and 2021.

The design is deliberately simple. A composite index of road transport development is correlated against fourteen indicators spanning demography, education, health, industry, agriculture and administration. The same correlations are run for two years, twenty years apart, and the difference between them is treated as the main finding. A single correlation tells you the state of a relationship at one moment; the change in correlation tells you whether the relationship is strengthening, fading or reversing. For a question about whether roads have become more important to development, that second reading is the one that matters.

Two hypotheses frame the analysis. The first is that road development is significantly associated with the key sectors of regional development in the district. The second, implicit in the two-period design, is that this association has intensified over time. The results bear on both, but they also do something the hypotheses did not anticipate: they show that the intensification is sharply selective, pulling some sectors toward the road network while pushing others away.

The question sits in a long line of research linking roads to development. Jacoby's study of rural Nepal found that extending roads into remote areas lowered the cost of reaching markets, schools and health facilities, benefits that fell disproportionately on the poor. Indian regional studies have tended to reach a similar verdict while adding a spatial twist: road development improves aggregate access but often concentrates its gains. Rani's work on Haryana, using Z-scores and correlation much as this study does, found that better-connected districts showed higher urbanisation and industrialisation while poorly connected ones lagged, and Chisti reported the same for West Bengal. The Solapur case allows a sharper test of this concentration effect, because it tracks the correlations across two decades rather than at a single moment, and so can show not just whether roads and development go together but whether their relationship is tightening.

Data and Method

The composite index of road transport development was built by standardising three road indicators, namely the index of road network, road length per hundred square kilometres and road length per lakh of population, and combining them into a single Z-score for each tahsil. Positive values mark tahsils with above-average road provision and negative values mark those below. This index served as the independent variable throughout.

Fourteen regional development indicators were assembled for the eleven tahsils for 2001 and 2021. They include road density and village road connectivity; rural population and population density; literacy and schools per hundred square kilometres; sex ratio and hospitals per lakh; co-operative societies and post offices per lakh; factories per hundred square kilometres; and irrigated land, net sown area and agricultural employment. Karl Pearson's product-moment correlation was computed between the road index and each indicator, separately for the two years. The coefficient runs from −1 to +1, with values beyond about 0.7 read as strong, 0.4 to 0.7 as moderate, and below 0.4 as weak. The change measure is simply the 2021 coefficient minus the 2001 coefficient.

Results

1 The overall pattern of change

Table 1 lays out the two sets of coefficients and the change between them. The eye is drawn immediately to the change column, because several of its entries are large. Schools per hundred square kilometres swing by nearly one and a half points, from a strong negative to a strong positive. Hospitals and factories each swing by more than eight-tenths of a point in the positive direction. Sex ratio, co-operative societies and road density all strengthen markedly. Against this, irrigated land moves the other way, from a weak positive to a moderate negative, and rural population becomes more strongly negative. Net sown area and agricultural employment barely move. The overall shape is a broad strengthening of positive links with non-agricultural sectors and a stable or worsening relationship with agrarian ones.

2 Sectors pulled toward the road network

The clearest cases of intensification are industry, health and education. In 2001 the correlation between road development and factory density was essentially zero, at 0.004; industrial location in the district owed more to the historical weight of North Solapur than to any tahsil's road endowment. By 2021 the coefficient had risen to 0.807, a strong positive. Over the same period the relationship with hospitals per lakh moved from a weak negative of −0.126 to a strong positive of 0.693, and the relationship with schools per hundred square kilometres reversed outright, from −0.664 to 0.814. These reversals are striking because they are not gradual drifts but changes of sign and strength together, which suggests a real reorganisation of where these facilities locate rather than statistical noise.

Demographic concentration followed the same logic. Population density strengthened its correlation with road development from a moderate 0.485 to a strong 0.825, and road density itself rose from 0.519 to 0.887. Taken together, these results describe a district in which, by 2021, people, factories, schools and hospitals were increasingly found in the same well-connected tahsils. That clustering is what one would expect if road access had become a genuine determinant of location rather than a bystander to it.

3 Sectors left behind or pushed away

The agrarian indicators tell the opposite story, and they are just as consistent. The correlation between road development and rural population, already negative in 2001 at −0.476, deepened to −0.767 by 2021. Net sown area sat at a strong negative in both years, moving only from −0.634 to −0.645, which is effectively no change. Agricultural employment stayed moderately negative throughout. Most tellingly, irrigated land reversed the other way, from a weak positive of 0.279 to a moderate negative of −0.402, which says that by 2021 the tahsils gaining road infrastructure were not the tahsils with expanding irrigation. Irrigation followed water, not roads.

Two administrative and rural-institutional indicators behaved in an intermediate way. Village road connectivity stayed weak in both years and if anything slipped, from 0.178 to 0.118, meaning that overall road expansion did not translate into proportional gains in last-mile rural access. Post offices remained negatively correlated, though less so than before. Co-operative societies moved from a weak negative to a weak positive. None of these reached the strength of the industrial or educational links, which reinforces the central reading: the road-led transformation was real but confined to the modern, urbanising sectors.

The village-connectivity result is worth pausing on, because it is the clearest sign that aggregate road growth and rural access are not the same thing. Over two decades the district added thousands of kilometres of road, and yet the statistical link between overall road development and village-level connectivity weakened rather than strengthened. The likely reason is that the road investment which drove the composite index upward, national highways and higher-order district roads, is not the investment that improves last-mile access, which depends on rural feeder roads reaching individual settlements. A tahsil can climb the road-development index on the strength of a new highway passing through it while its interior villages remain on the same poor tracks they always had. This disconnect is precisely why a district can look increasingly well provided with roads at the aggregate level while its rural residents see little change in how easily they reach a market or a clinic.

Table 1. Correlation of the composite road transport development index with regional development indicators, 2001 and 2021

Regional development indicator	r (2001)	r (2021)	Change (Δr)
Road density	0.519	0.887	+0.368
Village road connectivity	0.178	0.118	−0.060
Rural population	−0.476	−0.767	−0.291
Number of literates	0.272	0.356	+0.084

Regional development indicator	r (2001)	r (2021)	Change (Δr)
Schools per 100 sq. km	−0.664	0.814	+1.478
Sex ratio	0.029	0.581	+0.552
Hospitals per lakh	−0.126	0.693	+0.819
Co-operative societies per lakh	−0.163	0.221	+0.384
Factories per 100 sq. km	0.004	0.807	+0.803
Post offices per lakh	−0.525	−0.234	+0.291
Irrigated land area	0.279	−0.402	−0.681
Net sown area	−0.634	−0.645	−0.011
Employment in agriculture	−0.411	−0.355	+0.056
Population density	0.485	0.825	+0.340

Source: *computed by the author from Pearson's correlation analysis of tahsil-level data.*

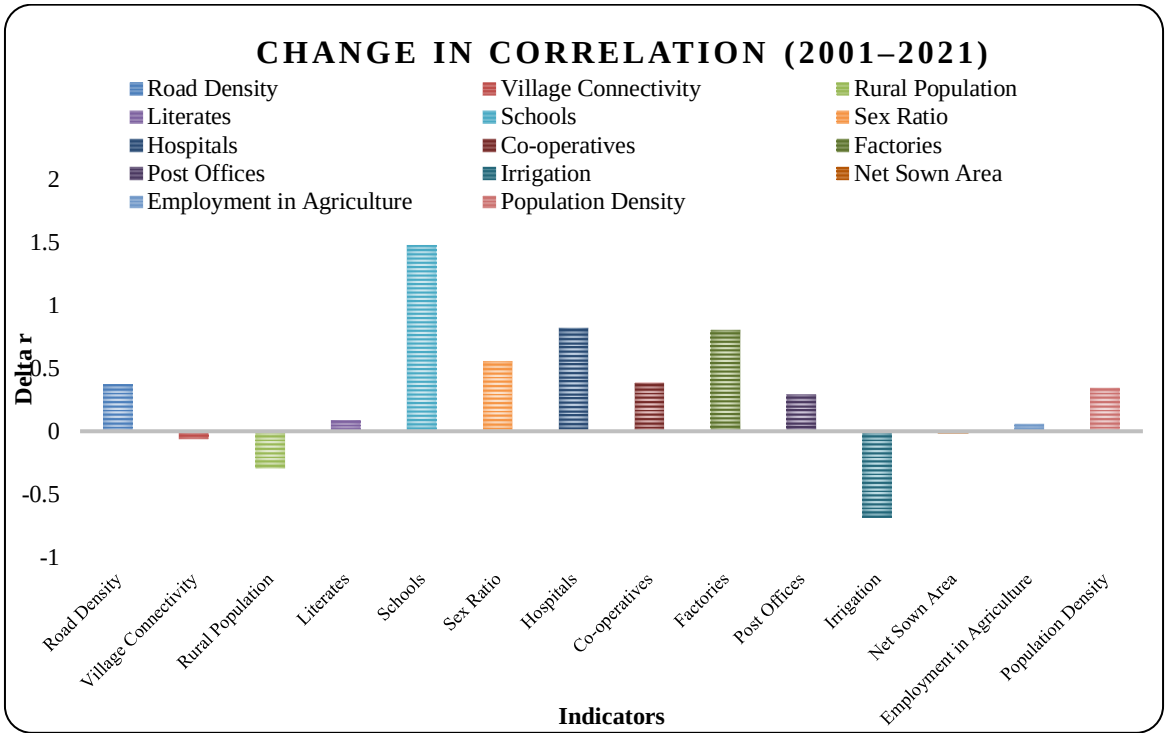

Fig No. 1: *Prepared by the researcher based on Pearson's correlation analysis (2001 & 2021)*

Discussion

The findings support both hypotheses without much ambiguity. Road development is significantly associated with the key sectors of regional development, and that association has intensified over the two decades. But the more interesting result is the selectivity of the intensification. Roads did not lift all sectors equally; they lifted industry, education, health and urban demographic concentration while leaving agriculture where it was. In effect, the road network became a sorting mechanism, channelling modern-sector growth toward the tahsils it served best and doing little to change the agrarian character of the tahsils it served least.

This has a spatial consequence that the correlations imply even though they do not map it directly. If the sectors that respond to roads are concentrating in the well-connected tahsils, and if road development itself is concentrating there too, then the district is pulling apart into a developed core and an agrarian periphery. The strengthening negative correlation with rural population is the clearest single signature of this: the more road-developed a tahsil, the less rural it now is, and that gap widened over the study period. Road building, in this district and over this period, coincided with divergence rather than convergence.

None of this means the roads caused the divergence on their own. Correlation is not causation, and industrial and educational location respond to many things besides road access, from historical inertia to state policy to the pull of an existing urban labour market. What the analysis does establish is that road development and modern-sector growth became tightly aligned over twenty years, and that agriculture was left outside that alignment. For policy, the implication is that road investment alone will not develop the agrarian tahsils. Without complementary investment in irrigation, storage, processing and rural markets, better roads in a farming tahsil mainly make it easier to leave.

1 Why the relationships reversed

The sign reversals in schools, hospitals and factories are the most arresting results, and they deserve an explanation rather than just a description. In 2001, several of these facilities were distributed according to an older logic. Schools per unit area were actually higher in some rural tahsils, because dispersed settlement and a policy emphasis on primary-education outreach spread small schools across the countryside, which produced the negative correlation with road development. Hospitals and factories were concentrated in North Solapur for historical and administrative reasons that had little to do with any tahsil's road endowment, so their correlation with the road index was near zero. In each case, road access was simply not the organising principle.

By 2021 that had changed. New industrial units, larger schools and expanded hospitals increasingly located where accessibility was best, because for these facilities road access lowers costs and widens catchments in a way that matters to the decision of where to build. As the newer, road-sensitive facilities accumulated, they pulled the overall distribution into alignment with the road network, flipping the correlation from negative or neutral to strongly positive. The reversal is therefore not a statistical accident but the visible trace of a change in how location decisions are made. Development in Solapur became more road-dependent over the two decades, and the correlation coefficients simply recorded the shift as it happened.

2 The limits of the analysis

A few cautions keep the findings in proportion. Eleven tahsils is a small sample, so individual correlation coefficients carry wide margins of uncertainty, and it is the consistency of the pattern across many indicators, rather than any single coefficient, that should be trusted. The composite road index and the development indicators are also measured at the tahsil level, which averages over real variation between villages inside each tahsil. Some of the 2021 demographic figures rest on projections because of the delayed census, which adds a further layer of approximation. And correlation, as already noted, cannot establish direction; a positive coefficient is equally consistent with roads attracting factories and with factory towns attracting roads. These limits do not undermine the central result, which is robust precisely because it shows up across so many sectors in the same direction, but they do argue for reading the coefficients as indicators of a pattern rather than as precise measurements.

Conclusion

Between 2001 and 2021 the relationship between road transport and regional development in Solapur district did not just strengthen; it changed character. Sectors that had been unrelated or even negatively related to road development, especially industry, healthcare and schooling, became strongly positively related, and population concentrated in the same well-connected tahsils. Agricultural indicators moved the other way or stayed put, and the link with rural population became more sharply negative. The two hypotheses are accepted, but with an important qualification written into the results: road transport has become a driver of development in Solapur, and the development it drives is industrial and urban, not agrarian. Closing the resulting gap will take more than roads.

Acknowledgement

The authors sincerely express their gratitude to Walchand College of Arts & Science, Solapur, for providing the academic environment and institutional support necessary to undertake this research. The authors are thankful to the concerned departments, institutions, and sources that provided the data and information required for analysing road transport development and regional development in Solapur District.

The authors also acknowledge the valuable academic guidance and support received during the preparation of this research paper. The study was made possible through the systematic compilation and analysis of tahsil-level data for 2001 and 2021 and the application of Pearson’s correlation analysis. The authors are grateful to all those who contributed directly or indirectly to the successful completion of this research work.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

1. Fisher, R. A. (1925). Statistical methods for research workers. Edinburgh: Oliver & Boyd.
2. Haughton, G., & Hunter, C. (2004). Sustainable cities. London: Routledge.
3. Jacoby, H. G. (2000). Access to markets and the benefits of rural roads. Economic Journal, 110(465), 713–737.
4. Pearson, K. (1896). Mathematical contributions to the theory of evolution. Philosophical Transactions of the Royal Society A, 187, 253–318.
5. Rani, S. (2016). Road transport network and regional development in Haryana (Doctoral dissertation). Maharshi Dayanand University, Rohtak.
6. Ullman, E. L. (1954). Transportation geography. In American geography: Inventory and prospect. Syracuse: Syracuse University Press.
7. Kale, Mr Mohan K. "The Impact of Road Transport on Regional Development: A Comprehensive Analysis." *IIP: International Multidisciplinary Research Journal* 1.Issue-IV (Oct-Dec) (2024): 7-7.